Draft Bacteria TMDL for Roses Creek

Brunswick, Virginia

Public Meeting # 2
Lawrenceville, VA

March 15, 2004

Acknowledgements

- Christopher French, Project Manager – Department of Environmental Quality
- Mark Alling – Department of Environmental Quality
- Denise Moyer – Department of Environmental Quality
- Dave Lazarus– Department of Environmental Quality
- Jutta Schneider – Department of Environmental Quality
- Ram Gupta – Department of Environmental Quality
- Bill Keeling – Department of Conservation and Recreation
- Barry Hughes – Department of Conservation and Recreation
- Tim Ott – Department of Conservation and Recreation
- Mike Faulk – Natural Resources Conservation Service
- Cynthia Gregg – Lake County Soil and Water Conservation District
- Marc Puckett – Virginia Game and Inland Fisheries
- Mark Sadler – Department of Health
- Bob Stemple – Department of Forestry
- Jeff Swanson – Town of Alberta
- C. J. Dean – Town of Lawrenceville
- Melissa Parrish – Town of Alberta
- Harold Jones – Town of Lawrenceville

The citizens and stakeholders who attended the public meetings

Recap of Stakeholder Meeting No.1

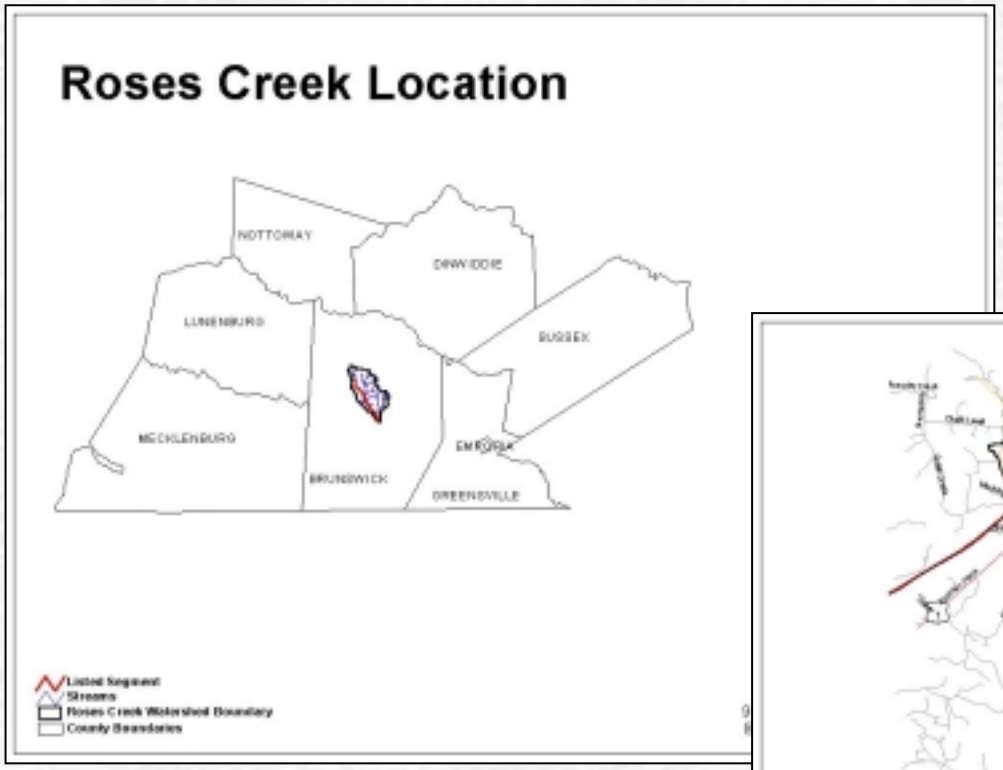
Stakeholder Meeting 1

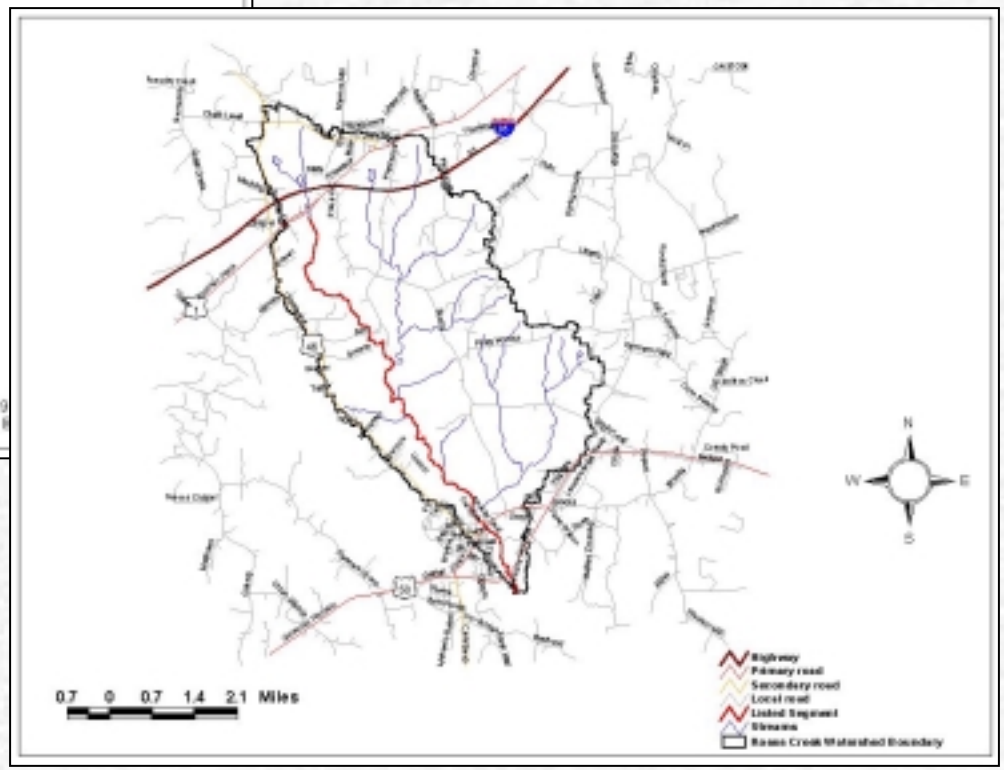
- Discussed what is a TMDL? Why? and how?
- Presented the Roses Creek listed segment
- Reviewed the steps used in the TMDL development
- Reviewed the data used in the TMDL development
- Presented preliminary Bacteria Source Tracking (BST) results
- Presented the fecal coliform sources assessment
- Presented the TMDL Technical Approach

Objectives

- To present and review the steps and the data used in the development of the bacteria TMDL for the listed segment of Roses Creek.
- To present the Hydrologic calibration and Validation of the Model
- To present the Water quality calibration and Validation of the Model
- To present the Draft TMDL

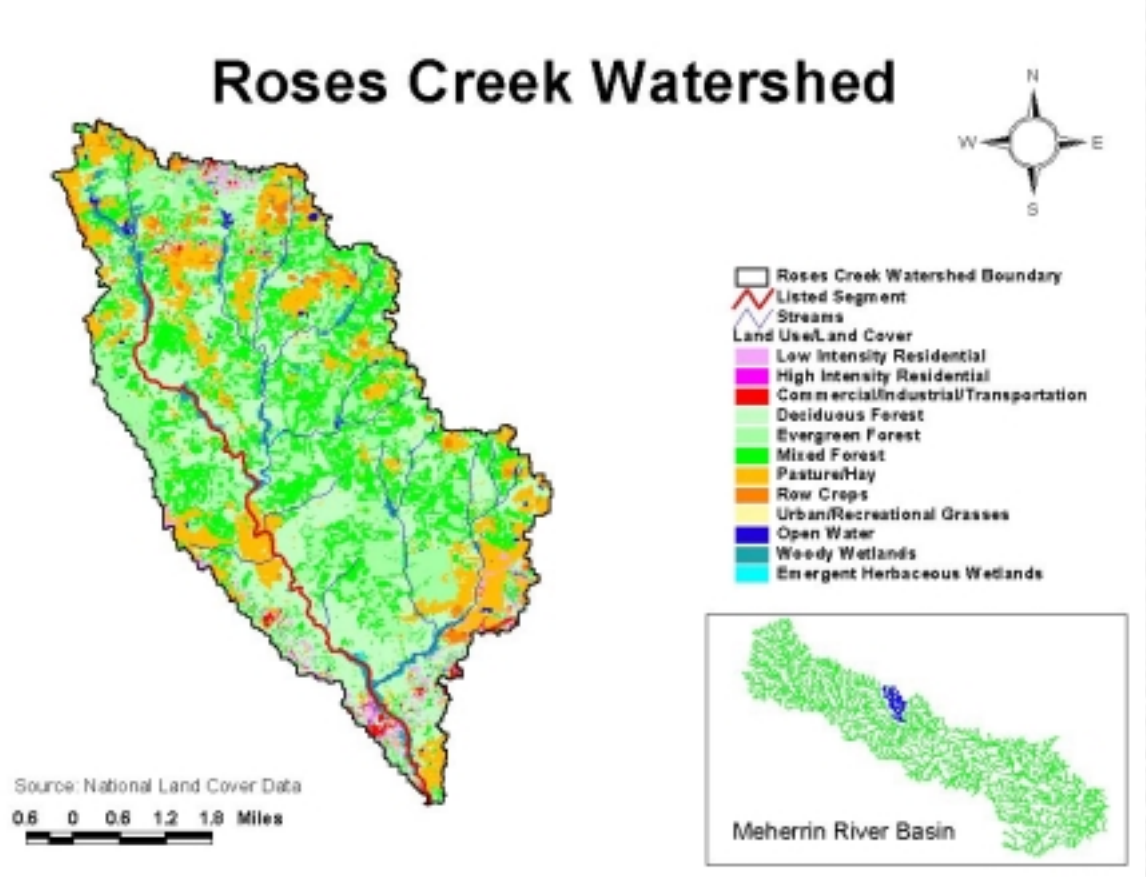
Roses Creek Watershed





Roses Creek Watershed

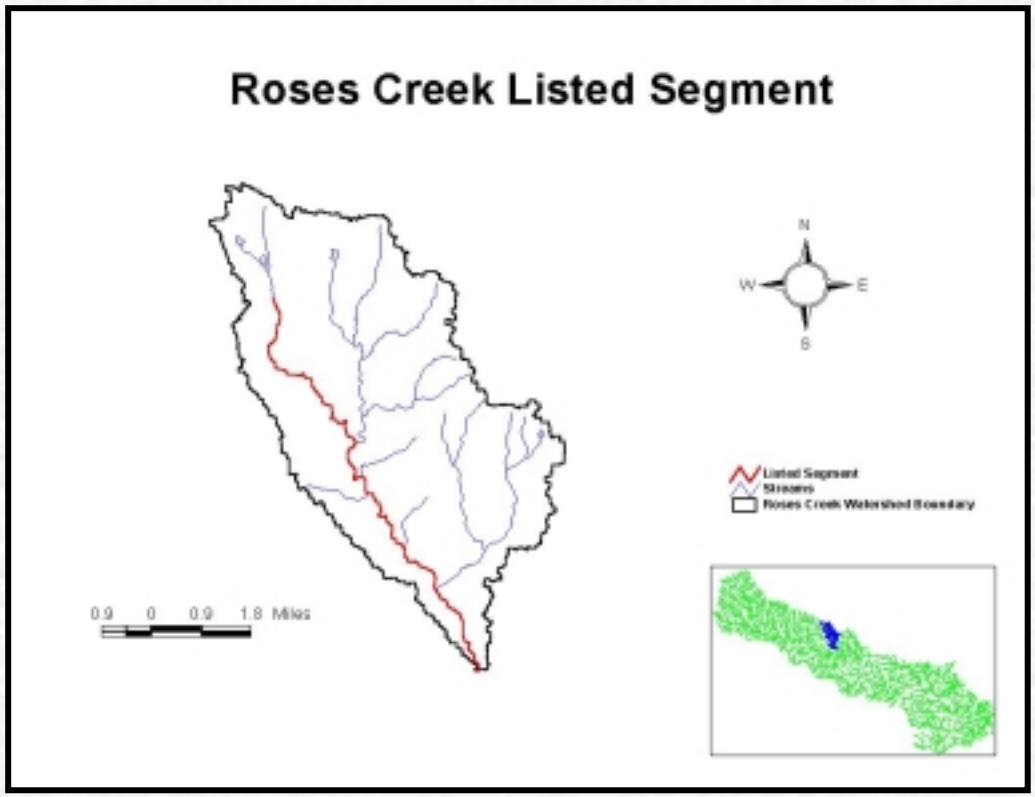
- **Watershed Area is 17,725 acres**
- **Dominant land uses**
  - **74% Forestland**
  - **19% Agriculture (Pasture/Hay and Crop Land)**



Roses Creek Listed Segment

Based on the 2002 303(d) List

- **Upstream Limit**
  - Town of Alberta STP discharge
  - River Mile 9.83
- **Downstream Limit**
  - Great Creek Confluence
  - River Mile 0.00

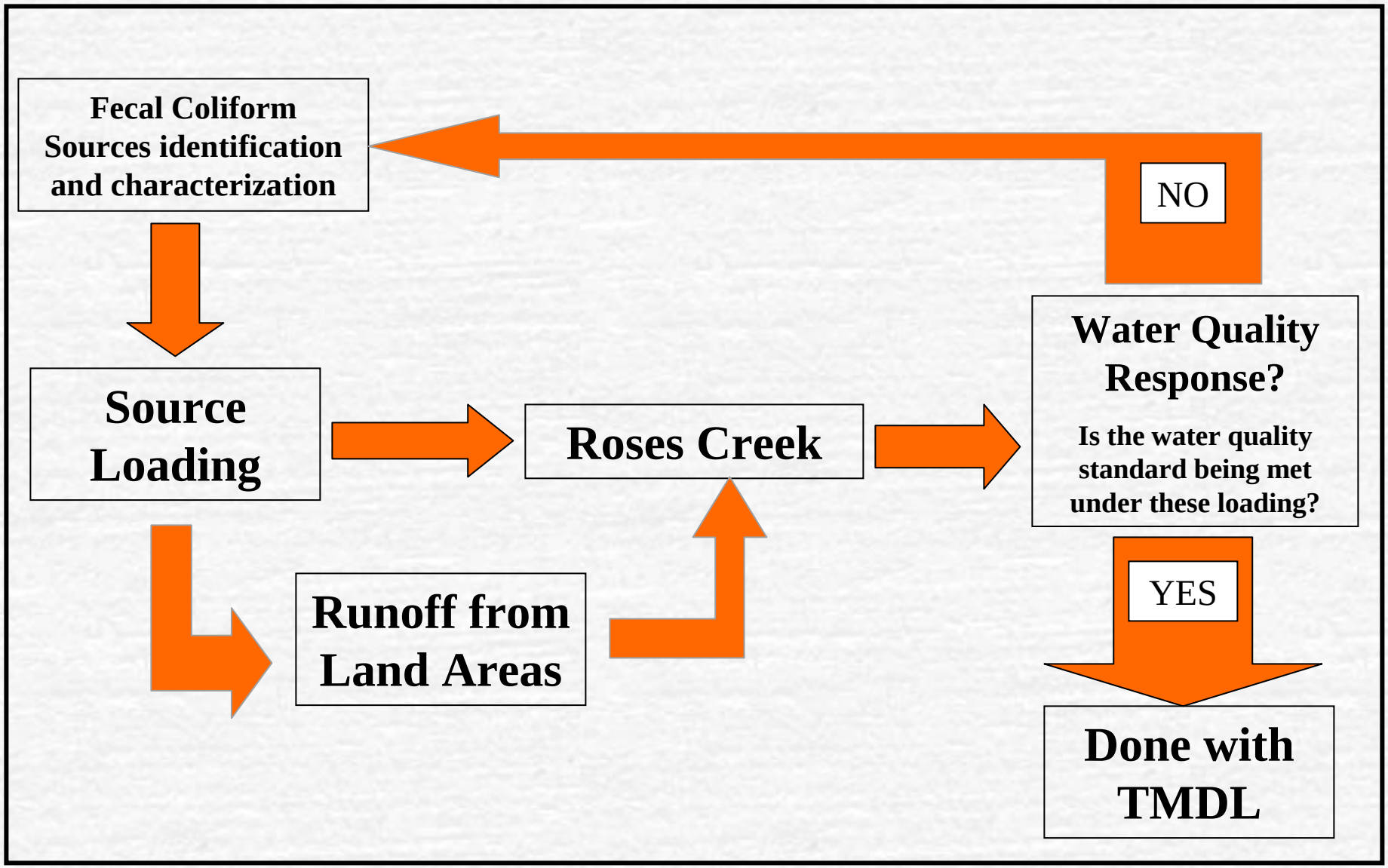


TMDL Process

TMDL Development Process

1. Define the **problem**
2. Define the **numeric targets** for fecal coliform
3. Identify and characterize fecal coliform **sources**
4. Estimate **loadings** under the existing conditions
5. Evaluate the **linkage** between the fecal coliform sources and instream response
6. Develop **allocation** scenarios that meet the water quality standards
7. Develop a follow up **monitoring** plan
8. Develop an **implementation** plan

TMDL Process



Water Quality Model

Hydrologic Simulation Program Fortran (HSPF)

- Hydrologic model
- Watershed model
- State of the art modeling system
- EPA approved approach

Source Loading Estimates

1. Estimate the size/number of each source
2. Determine whether the source is
   - Direct Source
   - Indirect Source
3. Determine the daily fecal coliform production by source
4. Calculate the land based and direct load based on monthly schedules
5. The sum of all the individual sources is the total load

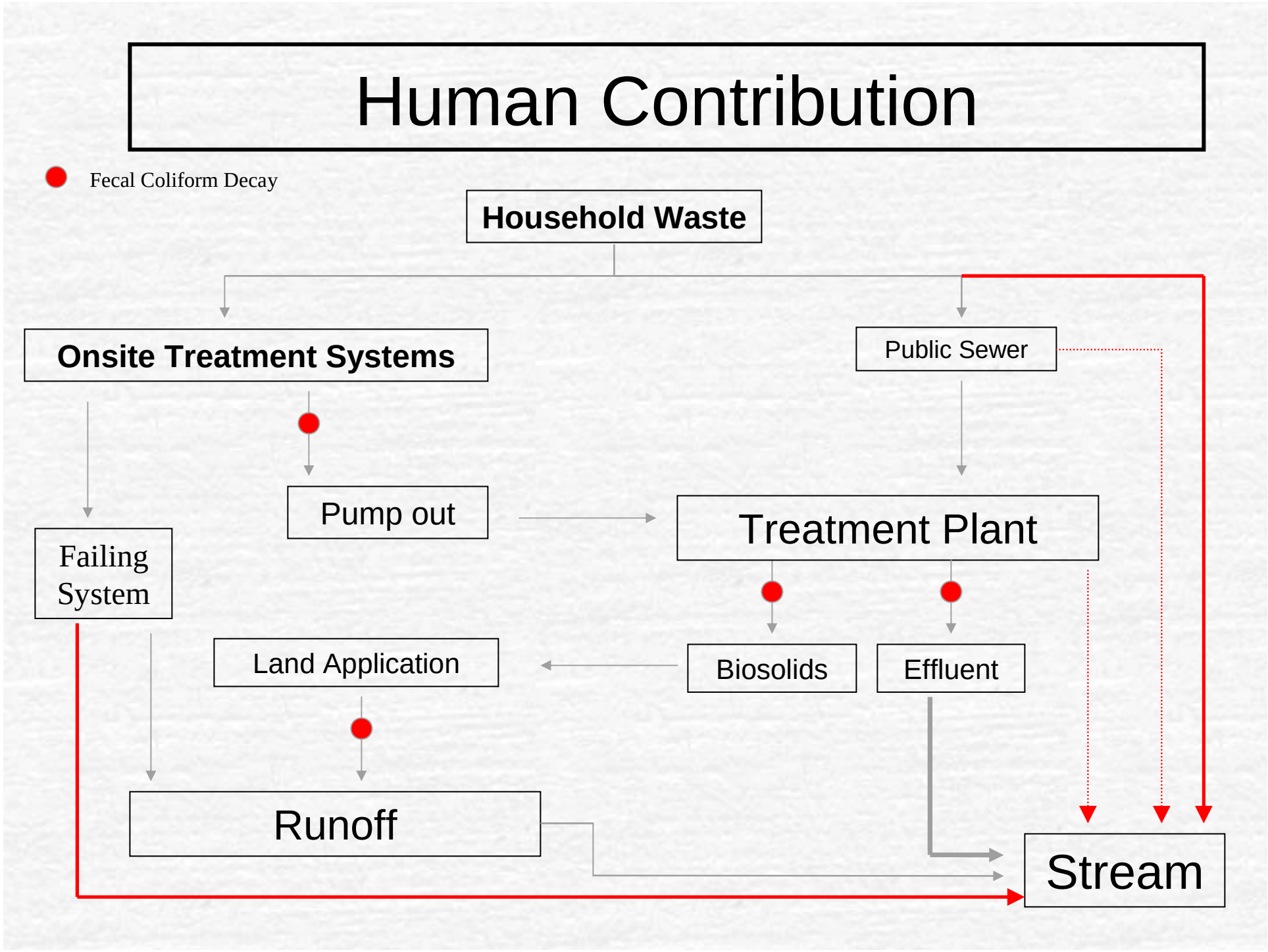
Fecal Coliform Production

Address fecal coliform loading from:

- Human Sources
- Livestock
- Wildlife
- Pets

Human Sources

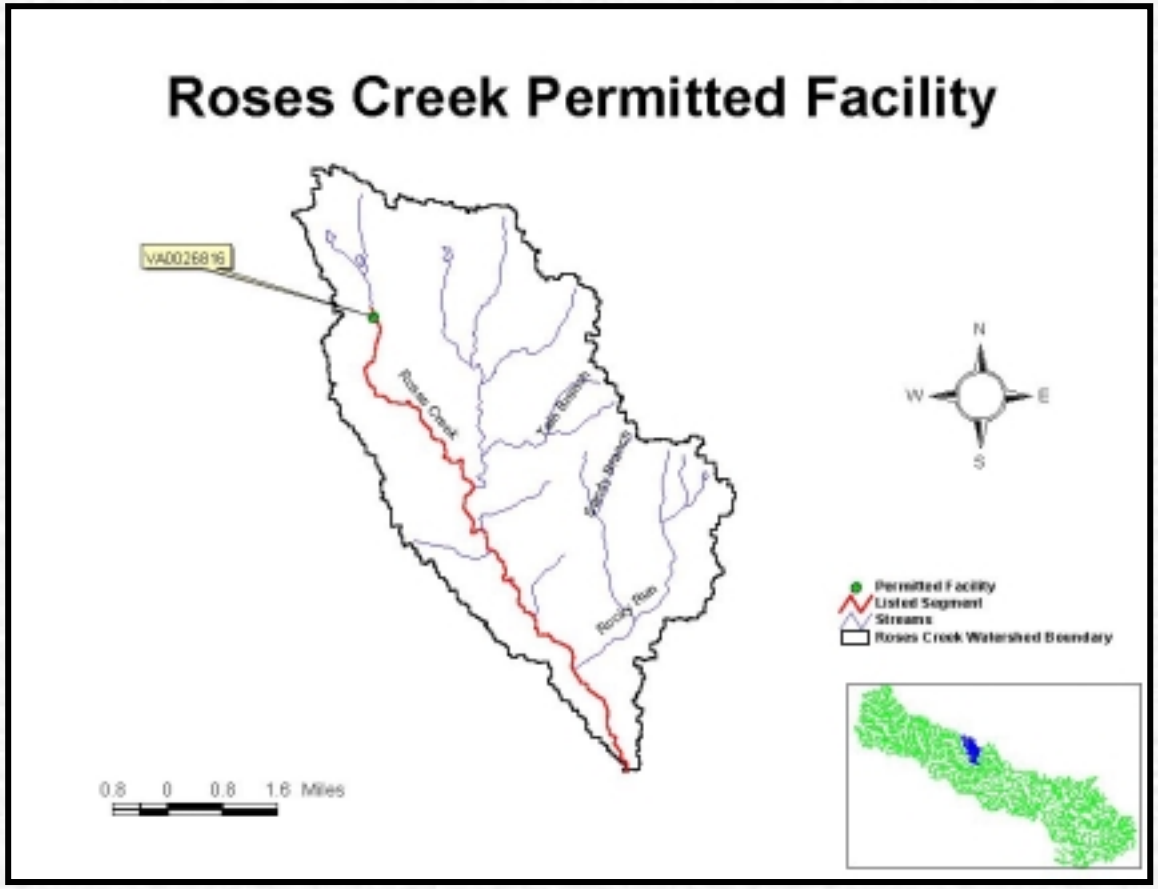
Human Contribution



Human Contribution

- Fecal coliform loading from Human sources
  - Permitted sources
  - Septic systems
    - Failure rates
  - Straight pipes
  - Land application of Biosolids
- Information Sources
  - Brunswick County Health Department
  - Town of Alberta Sewage Treatment Plant
  - Lawrenceville Sewage Treatment Plant
  - DEQ

Point Sources



- Town of Alberta STP (Permit No. VA0026816)

Septic Systems/Straight Pipes Loading

- Population in Roses Creek watershed is about **2,400** people
- Total number of households in the watershed is **841**
  - Number of households on sewer is **261**
  - Number of households on septic system is **580** or (78%)
- Assuming a septic system failure rate of 3%
- Assuming straight pipes constitute 5% of the septic systems installed in the 1960s
- Septic system design flow is 75 gal per person per day
- Typical fecal coliform concentration from:
  - Failed septic systems is 10,000 cfu/100 ml
  - Straight pipe is 1,000,000,000 cfu/100 ml

Land Application of Biosolids

- No land application of biosolids in the Roses Creek watershed

Pets

Pets: Dogs and Cats

Pasture | Cropland | Forest | Built-up area

Runoff

Stream

Fecal Coliform Decay

Fecal coliform Loading from Pets

- Pet inventories based on
  - 1.7 Dogs per household
  - 2.2 Cats per household

- 841 households in Roses Creek watershed
  - 1,430 Dogs
  - 1,850 Cats

Source: Lehigh Valley Animal Rights Coalition for US Averages

Livestock

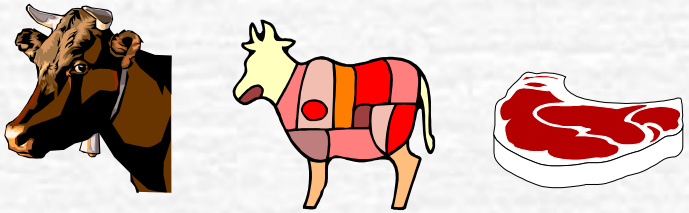
Livestock Inventory

- No dairy operations exist in the Roses Creek watershed
- Beef cattle present on pasture areas of the Roses Creek Watershed

- No poultry operations in Roses Creek watershed
- No swine operations in Roses Creek watershed
- No feedlots are located in Roses Creek watershed

- Alternative water has not been implemented in Roses Creek Watershed

Fecal Coliform Decay



Beef Cows

Pasture

Confinement

Manure Storage

Manure Spreading

Pasture

Cropland

Runoff

Stream

Livestock Inventory

Livestock	Watershed Totals
Beef Cattle	250
Dairy	0
Chicken	0
Horse	<10
Goat	<10
Sheep	0

Beef Cows - Confinement schedule

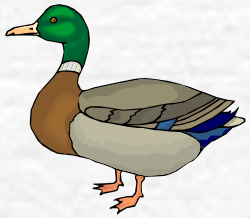
Month	Time Spent in		
	Pasture	Stream	Loafing Lot
	(Hour)	(Hour)	(Hour)
January	23.50	0.50	0
February	23.50	0.50	0
March	23.25	0.75	0
April	23.00	1.00	0
May	23.00	1.00	0
June	22.75	1.25	0
July	22.75	1.25	0
August	22.75	1.25	0
September	23.00	1.00	0
October	23.25	0.75	0
November	23.25	0.75	0
December	23.50	0.50	0

Source: Dodd Creek TMDL Report, DCR 2002

Manure Management

- Since no dairy or confined animal operations exist, manure application was not considered in Roses Creek TMDL

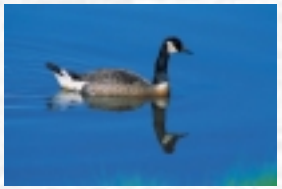
Wildlife



Wildlife

Pasture | Cropland | Forest | Built-up area

Runoff



Stream

Pollutant Decay

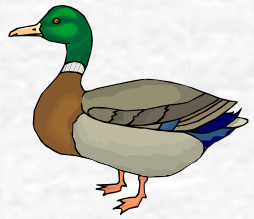
Wildlife

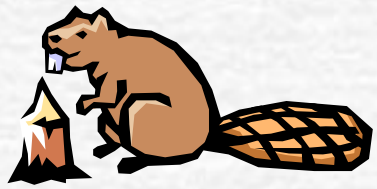
Loading from Wildlife will consider the following:

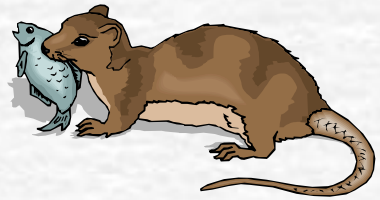
- Wildlife Inventory based on:
  - Habitat availability
  - Field observations
- Percent of time wildlife spend in the stream

Wildlife Inventory

Wildlife	Watershed Totals
Deer	837
Raccoon	413
Muskrat	1,783
Beaver	195
Goose	120
Mallard	50
Wood duck	50
Wild Turkey	172







Source Loading Estimates

Sources Loading Estimates

- Estimate the size/number of each source
- Determine the daily fecal coliform production by source
- Determine whether the source is
  - Direct Source
  - Indirect Source
- Calculate the load to each land use based on a monthly schedule and for each source
- The sum of all the individual sources is the total load

Daily Fecal Coliform Production by Source

Source	Daily Fecal Production (million) (cfu/day)
Human	1,950
Pet	450
Horse	420
Beef Cattle	33,000
Diary Cattle	
Milked or dry Cow	25,200
Heifer	11,592
Sheep	27,000
Deer	347
Raccoon	113
Muskrat	25
Beaver	0.2
Goose	799
Duck	2,430
Mallard	2,430
Wild Turkey	93

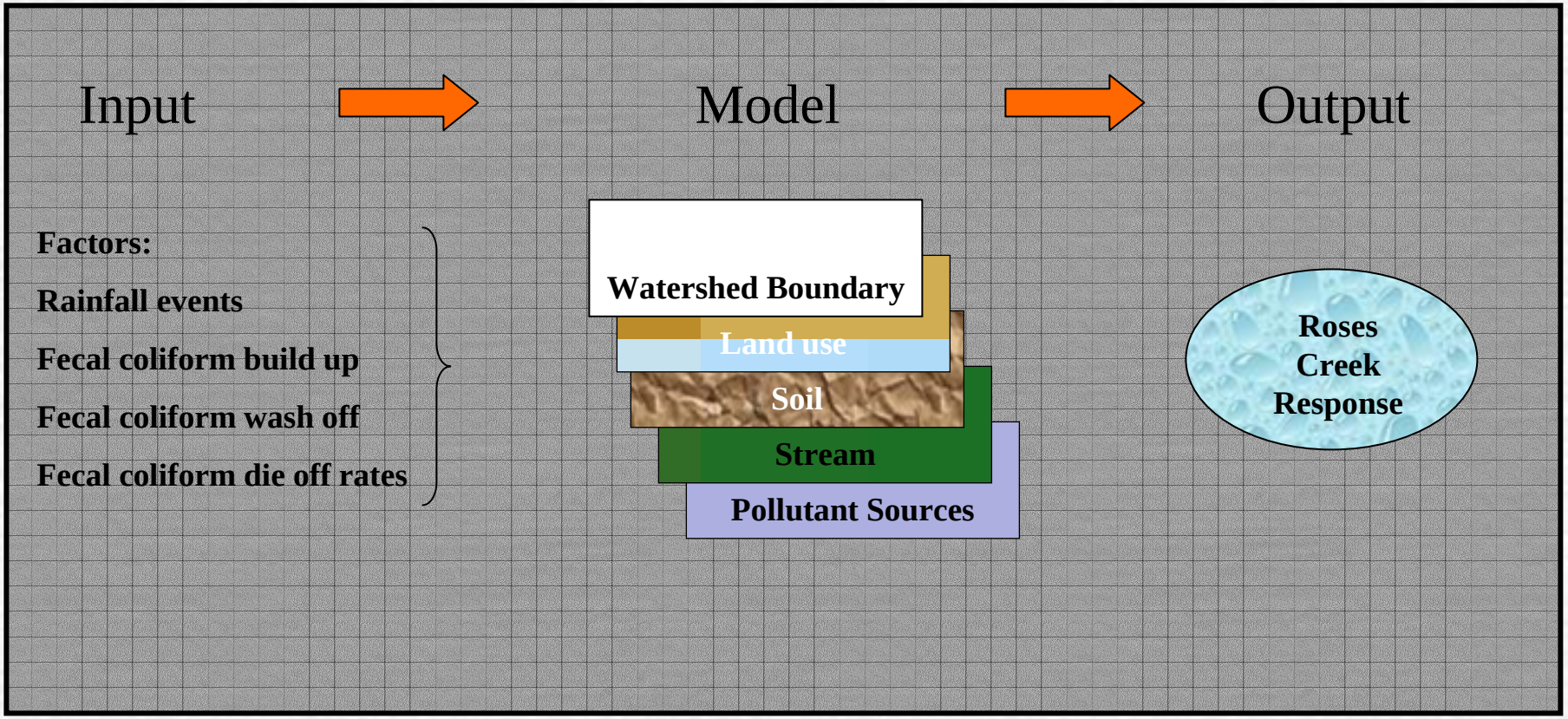
Source	The equivleant number of sources to one beef cow
Human	16.9
Pet	73.3
Horse	78.6
Beef Cattle	1.0
Diary Cattle	
Milked or dry Cow	1.3
Heifer	2.8
Sheep	1.2
Deer	95.1
Raccoon	292.0
Muskrat	1,320.0
Beaver	165,000.0
Goose	41.3
Duck	13.6
Mallard	13.6
Wild Turkey	354.8

Sources: ASAE, Map Tech, Metcalf & Eddy,

HSPF Model

HSPF model

Linking Sources to Water Quality



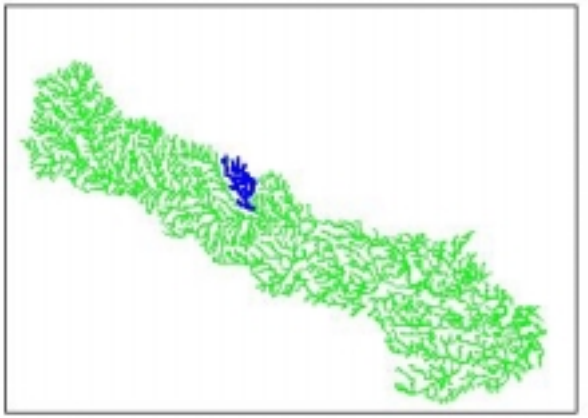
HSPF Model

- Model set up
- Model calibration
- Calibration results

Delineated Roses Creek Watershed

Listed Segment
Streams
Roses Creek Subwatershed Boundaries

0.6 0 0.6 1.2 1.8 Miles



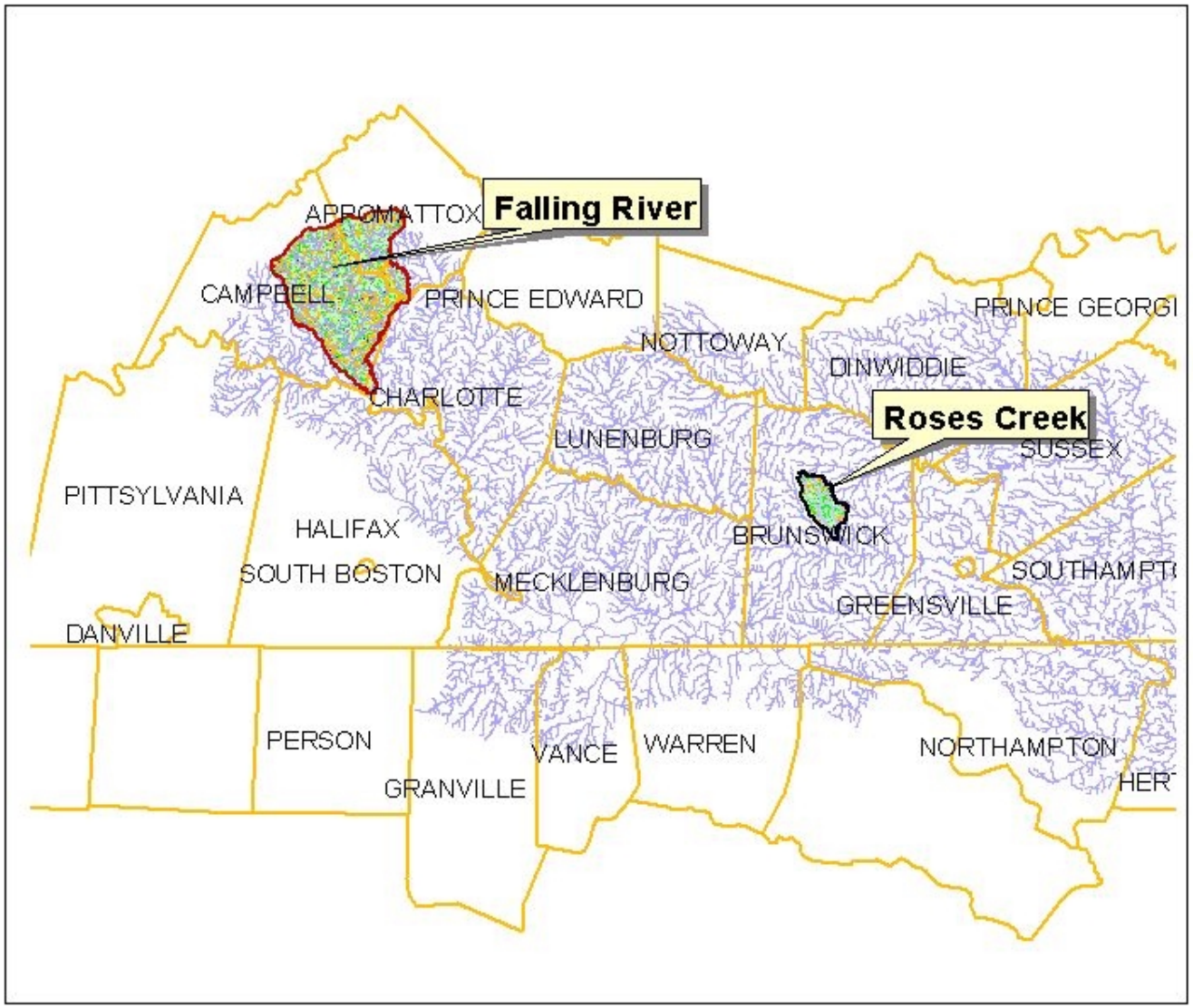
HSPF Model Setup

- Rainfall data
  - Lynchburg Airport
  - John H. Kerr Dam
- Stream Flow?

HSPF Model Setup

- No stream flow data exist for Roses Creek
- Paired Watershed approach
  - Established hydrological similarities between Falling River and Roses Creek watersheds based on:
    - ✓ Land use
    - ✓ Soil types
    - ✓ Elevation
    - ✓ Stream channel slope
    - ✓ Stream channel length

Roses Creek and Falling River Watersheds



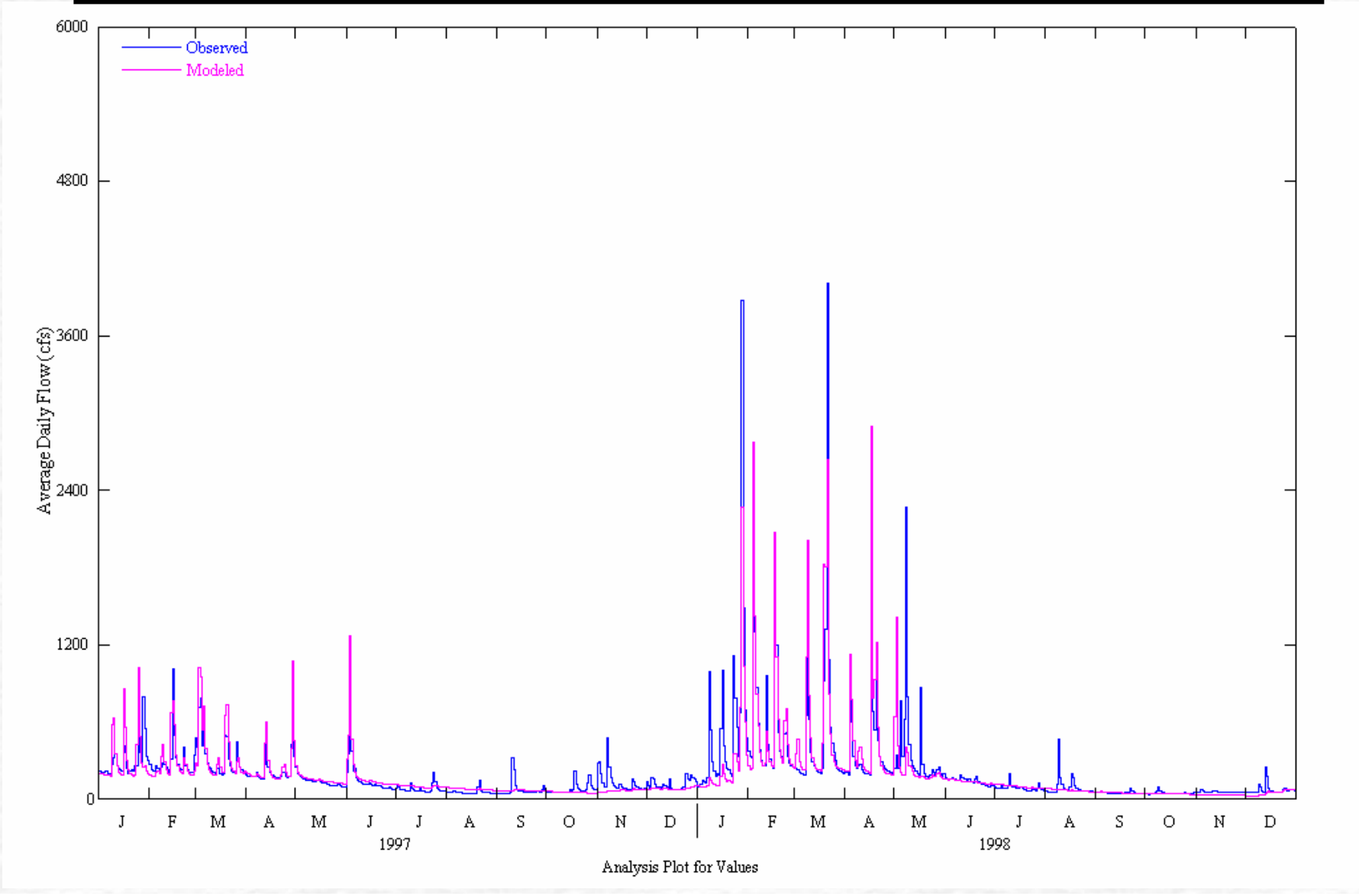
Land Use Comparison

Category	Land Use	% of Total Watershed	
		Roses Creek	Falling River
Forest	Deciduous Forest	32.1	40.7
	Evergreen Forest	18.3	11.6
	Mixed Forest	23.5	14.8
	Total Forested Land Uses	**73.9**	**67.1**
Agricultural	Pasture/Hay	16.4	25.4
	Row Crops	2.3	2.9
	Total Agricultural Land Uses	**18.7**	**28.3**
Urban	Low Intensity Residential	2.7	0.8
	High Intensity Residential	0.1	0.0
	Commercial/Industrial/Transportation	0.7	0.2
	Total Urban Land Uses	**3.5**	**1.0**
Water/Wetlands	Open Water	0.5	0.6
	Woody Wetlands	3.2	0.7
	Emergent Herbaceous Wetlands	0.2	0.1
	Total Water/Wetland Land Uses	**3.9**	**1.4**
Other	Transitional	3.7	2.3
	Total Other Land Uses	3.7	**2.3**

HSPF Model Runs

- Hydrologic Model:
  - Calibration period January 1997 - December1998
  - Validation period January 1996 – December 1996
- Water quality Model:
  - Calibration period January 1995 – December 1996
  - Validation period January 1998 – December 2000
- TMDL Calculation:
  - January1995 – December 2000

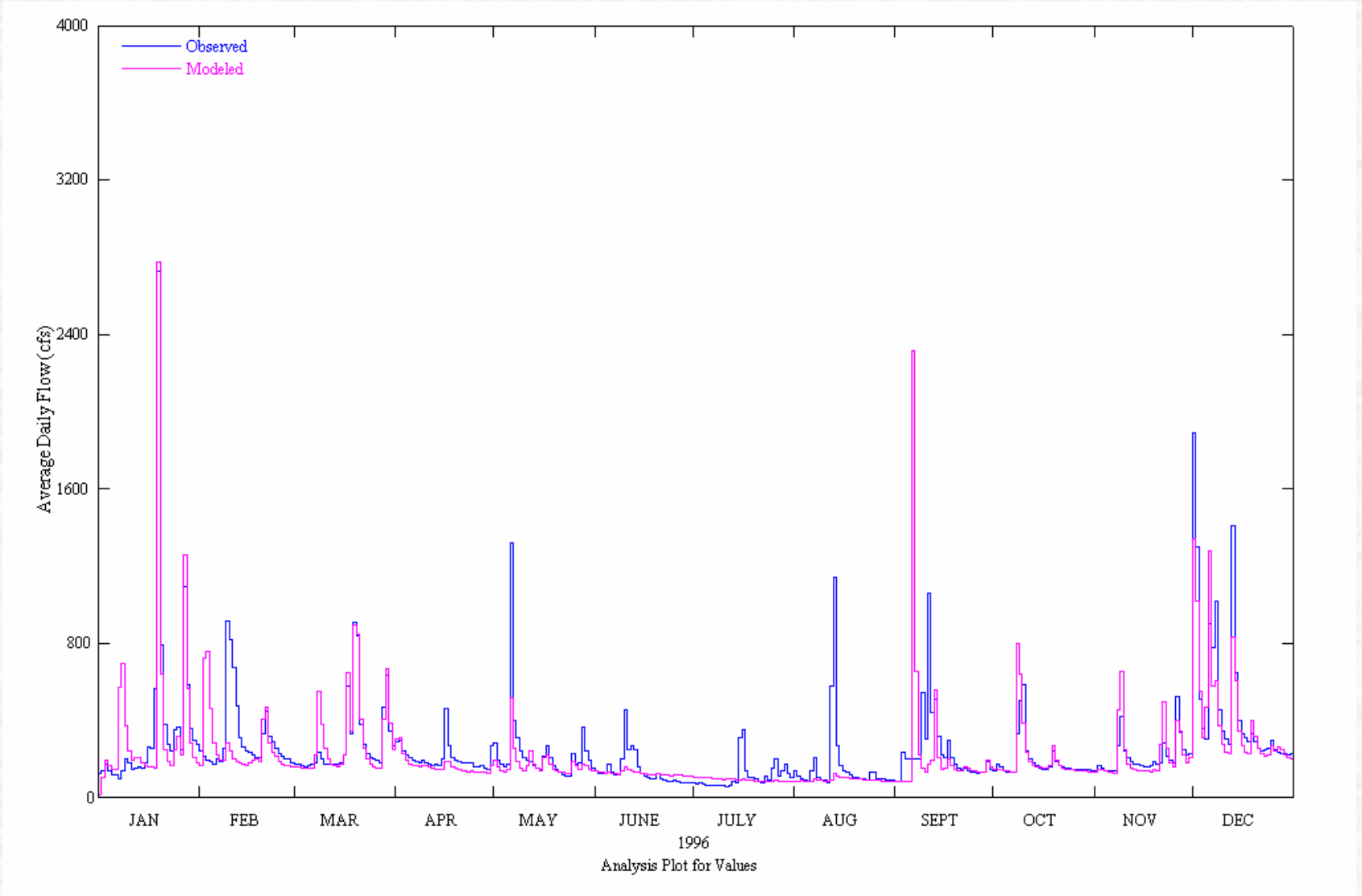
Hydrological calibration



Hydrological Calibration “Goodness of fit”

Category	Simulated	Observed
Total simulated in-stream flow (cfs)	33.60	33.08
Total of highest 10% flows, in inches	15.02	13.75
Total of lowest 50% flows, in inches	5.19	5.48
Total storm volume, in inches	5.55	4.39
Average of storm peaks, in cfs	756.45	570.53
Baseflow recession rate	0.99	0.96
Summer flow volume, in inches	4.75	4.17
Winter flow volume, in inches	11.81	12.46
Summer storm volume, in inches	1.02	0.85

Hydrological Validation

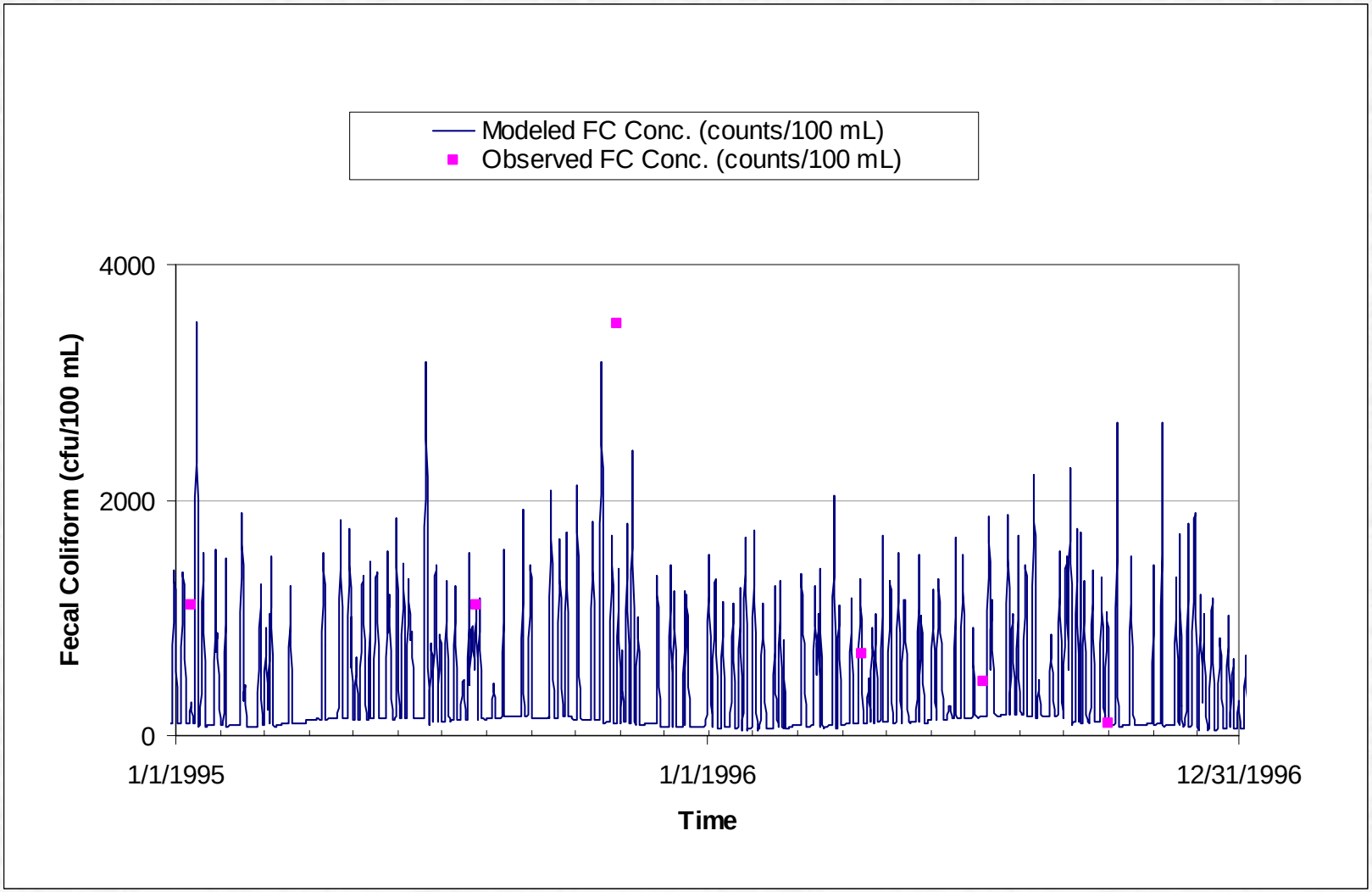


Hydrological Validation
"Goodness of fit"

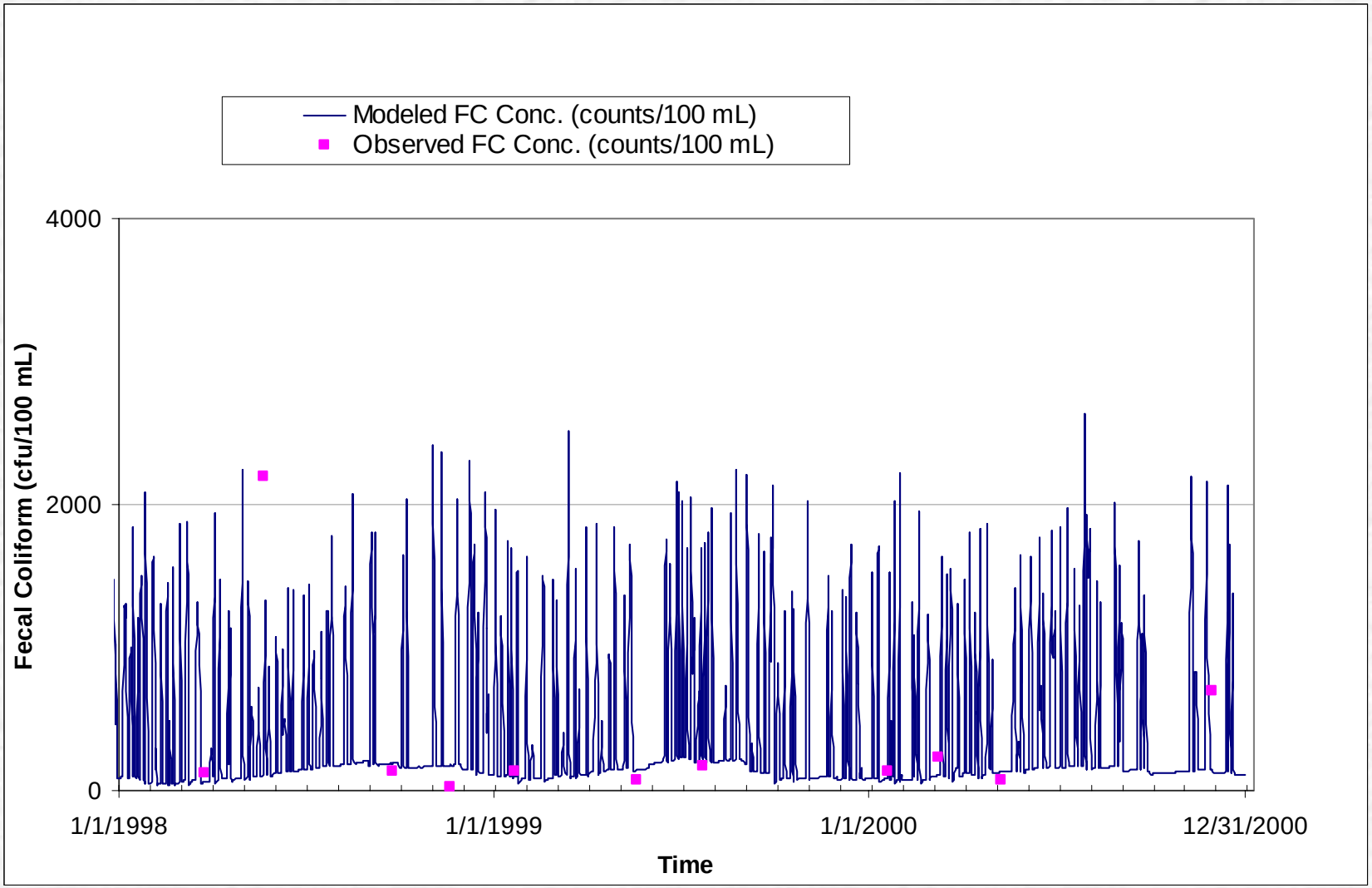
Category	Simulated	Observed
Total simulated in-stream flow, in (cfs)	18.30	20.21
Total of lowest 50% flows, in inches	4.87	5.34
Total of highest 10% flows, in inches	6.33	6.68
Total storm volume, in inches	0.95	1.07
Average of storm peaks, in cfs	400.46	439.78
Base flow recession rate	0.98	0.96
Summer flow volume, in inches	2.11	2.84
Winter flow volume, in inches	7.23	7.96
Summer storm volume, in inches	N/A[1]	N/A

1: Due to Hurricane

Water Quality Calibration



Water Quality Validation



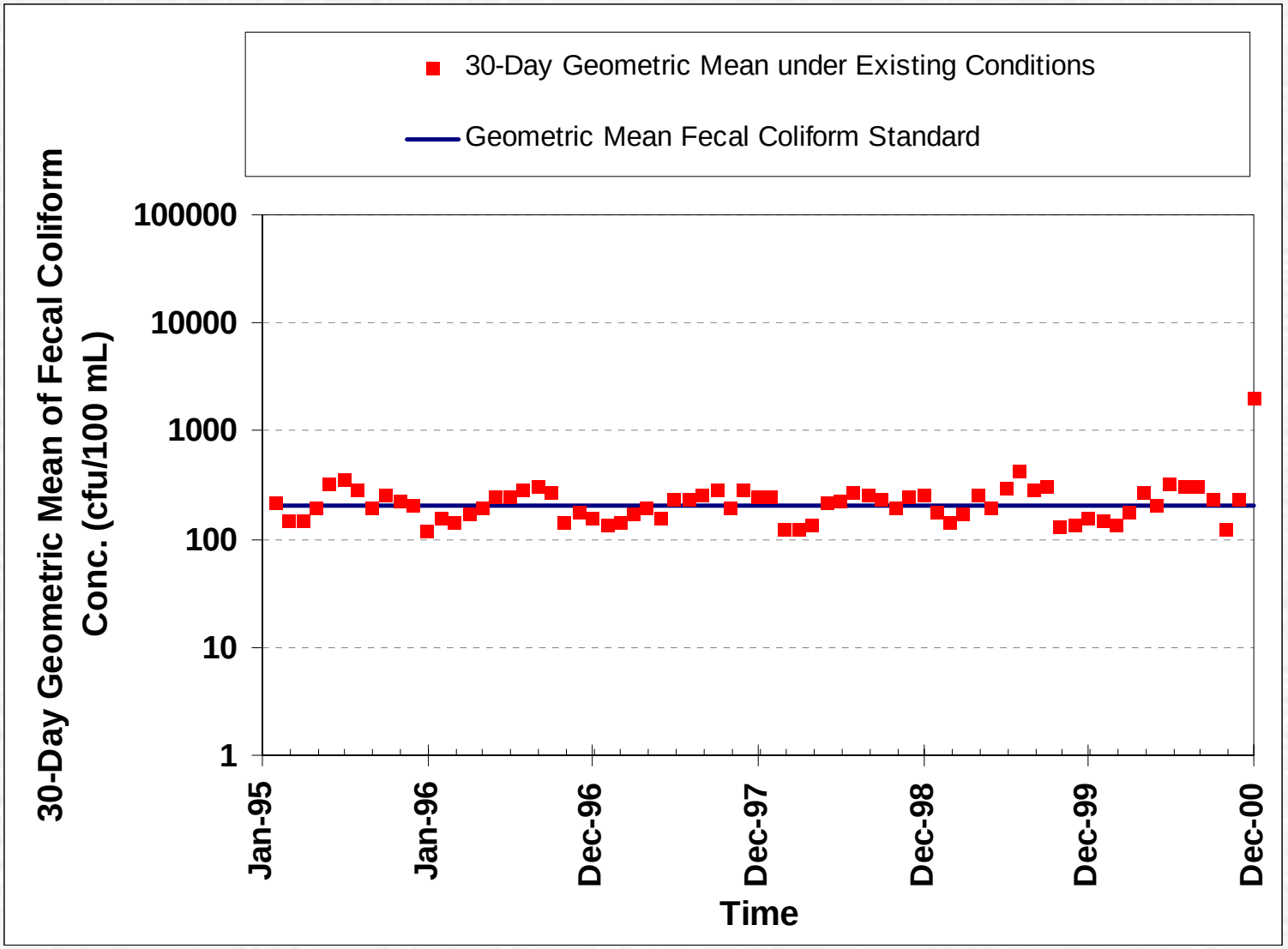
Annual Existing Fecal Coliform Load

Source	Annual Average Fecal Coliform Loads	
	cfu/year	Percent
Forest	3.33E+12	1.4
Cropland	1.37E+11	0.1
Pasture	1.18E+14	50.6
Low Residential	1.11E+14	47.5
High Residential	3.89E+11	0.2
Commercial/Industrial	1.38E+11	0.1
Water/Wetland	9.76E+09	0.0
Other	0.00E+00	0.0
Failed Septic	2.57E+06	0.0
Cattle Direct	3.01E+10	0.013
Wildlife Direct	1.47E+09	0.001
Point Source	2.76E+11	0.119
Total	**2.33E+14**	**100%**

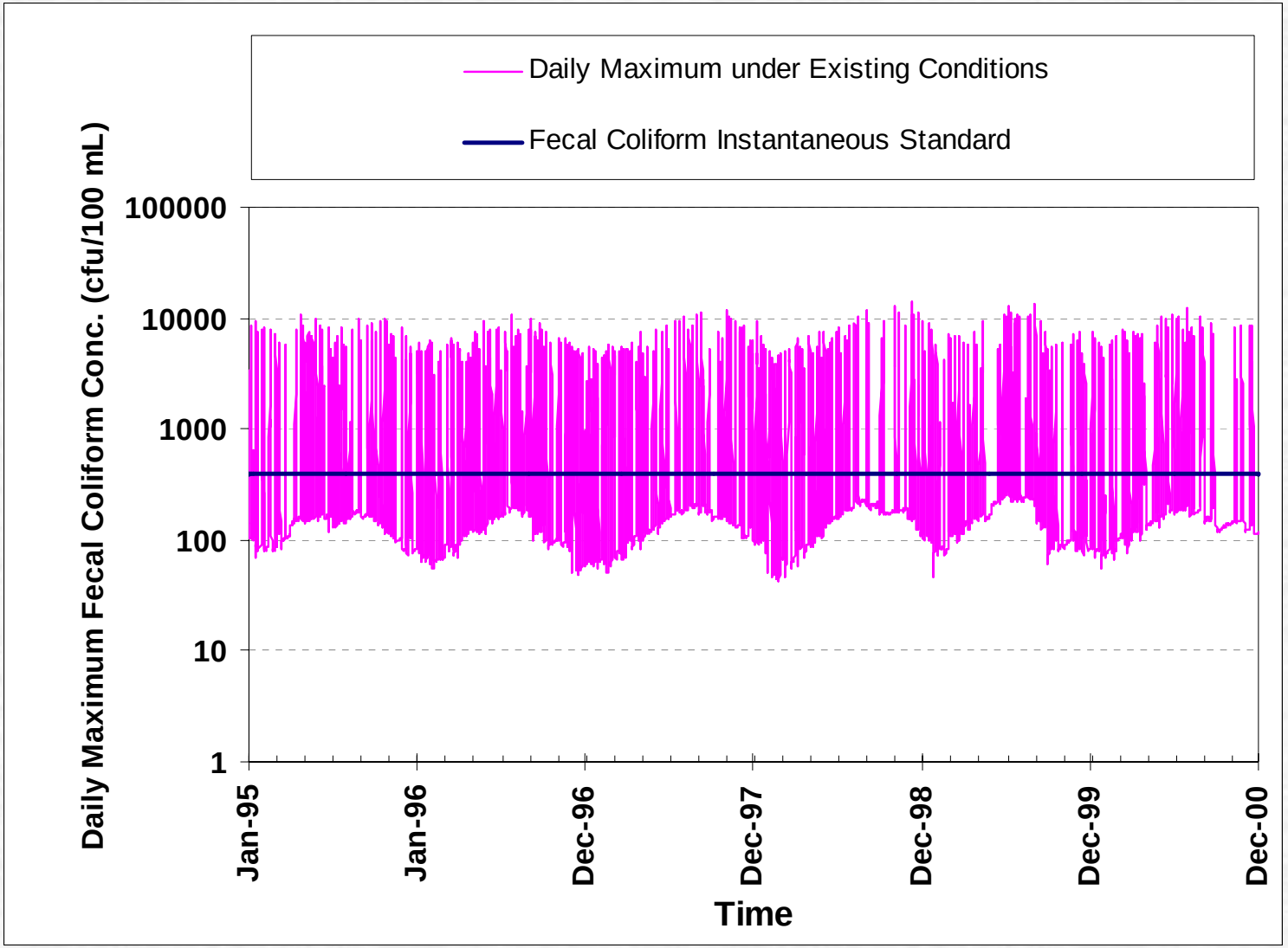
Annual Existing E. Coli Load

Source	Annual Average E. coli Loads	
	cfu/year	Percent
Forest	3.19E+11	1.90
Cropland	1.70E+10	0.10
Pasture	8.46E+12	50.15
Low Residential	7.98E+12	47.27
High Residential	4.43E+10	0.26
Commercial/Industrial	1.72E+10	0.10
Water/Wetland	1.50E+09	0.01
Other	0.00E+00	0.00
Failed Septic	7.70E+05	0.00
Cattle Direct	4.21E+09	0.02
Wildlife Direct	2.64E+08	0.00
Point Source	3.24E+10	0.19
Total	**1.69E+13**	**100%**

Model Existing Fecal Coliform Load



Model Existing Fecal Coliform Load

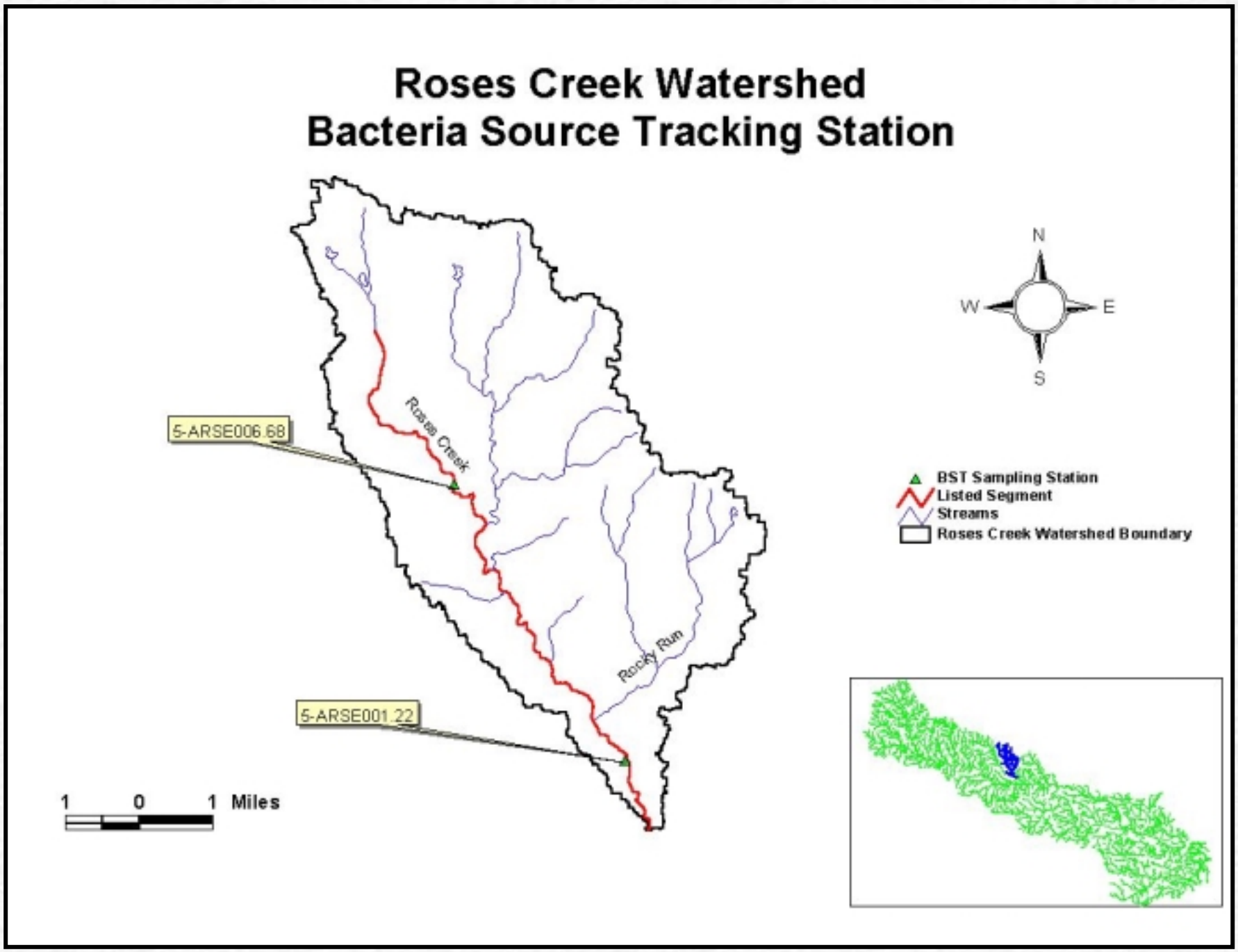


Bacteria Source Tracking

Bacteria Source Tracking

- Objective is to identify the sources of the fecal coliform in the stream.
- BST was developed at 2 stations within the Roses Creek watershed.
- Four categories considered
  - Human
  - Wildlife
  - Livestock
  - Pets

Roses Creek Watershed
Bacteria Source Tracking Station

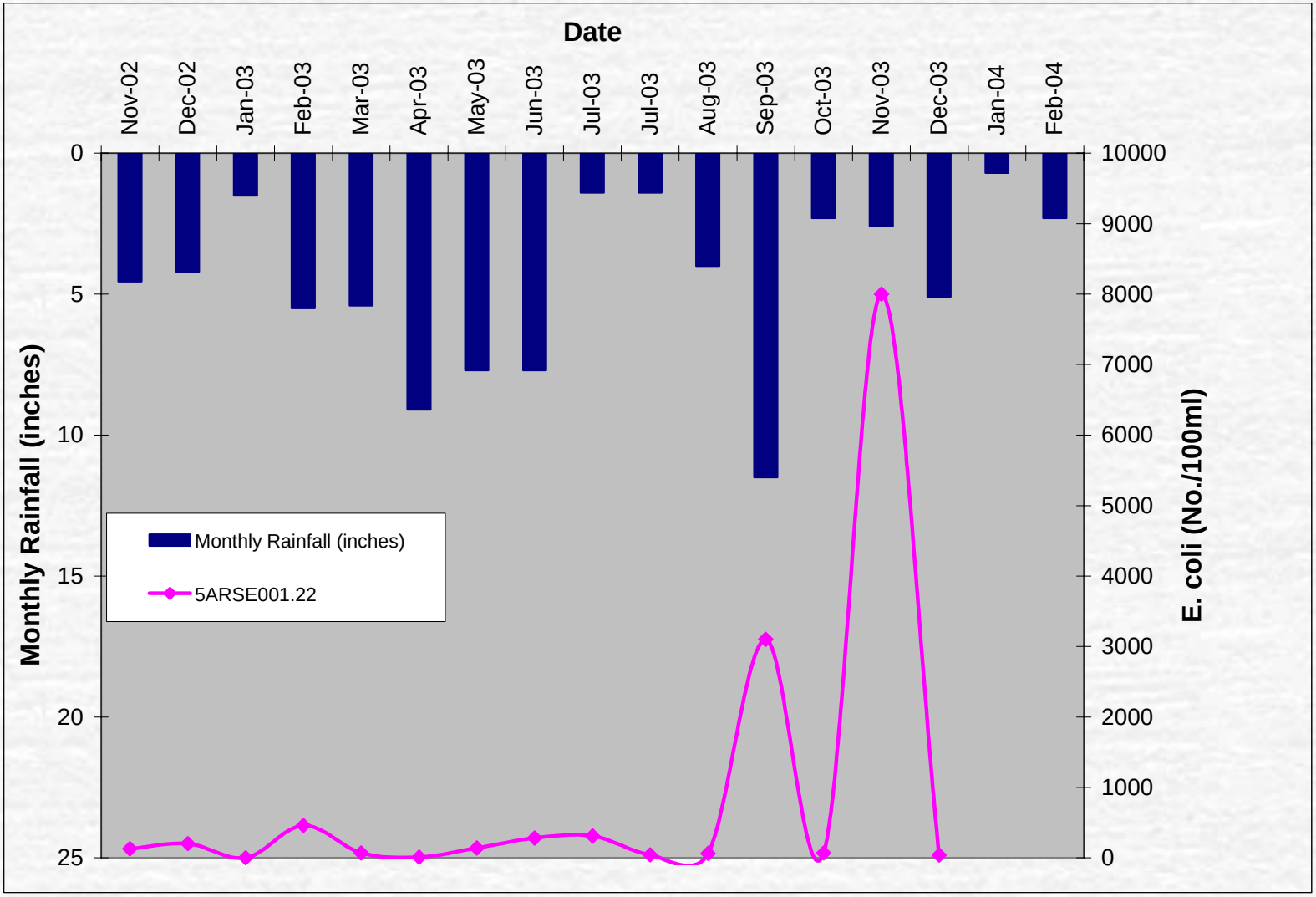


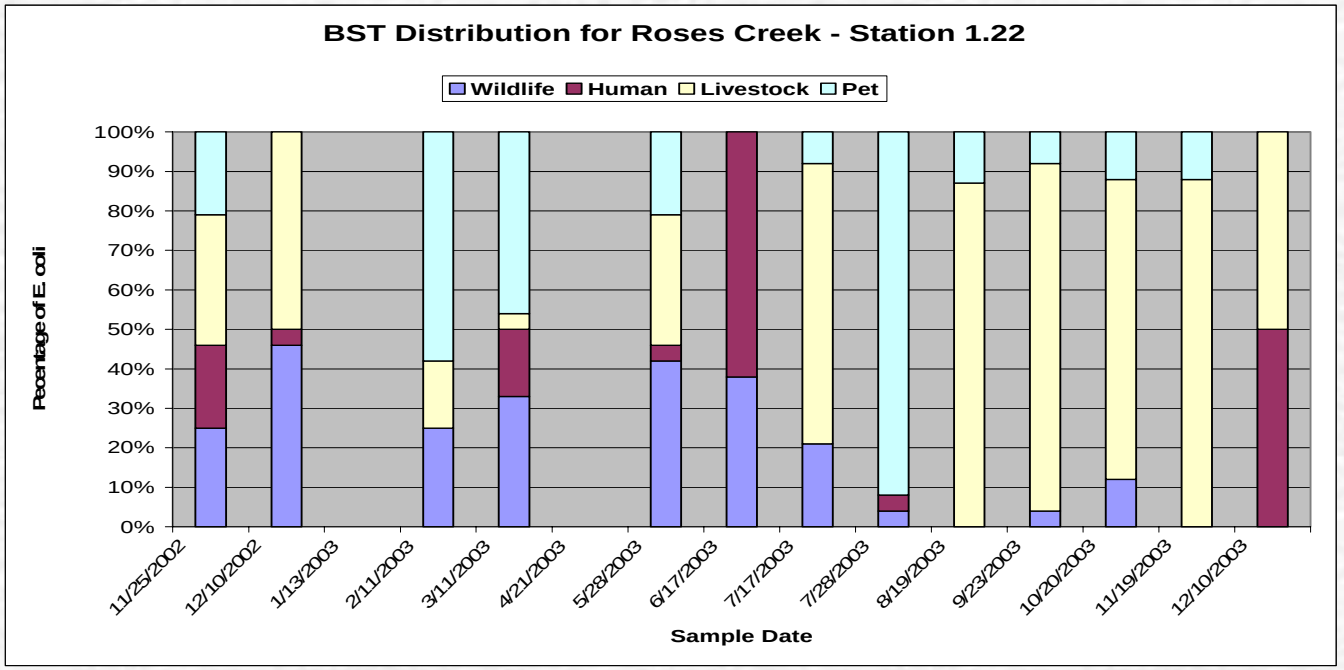
BST Results

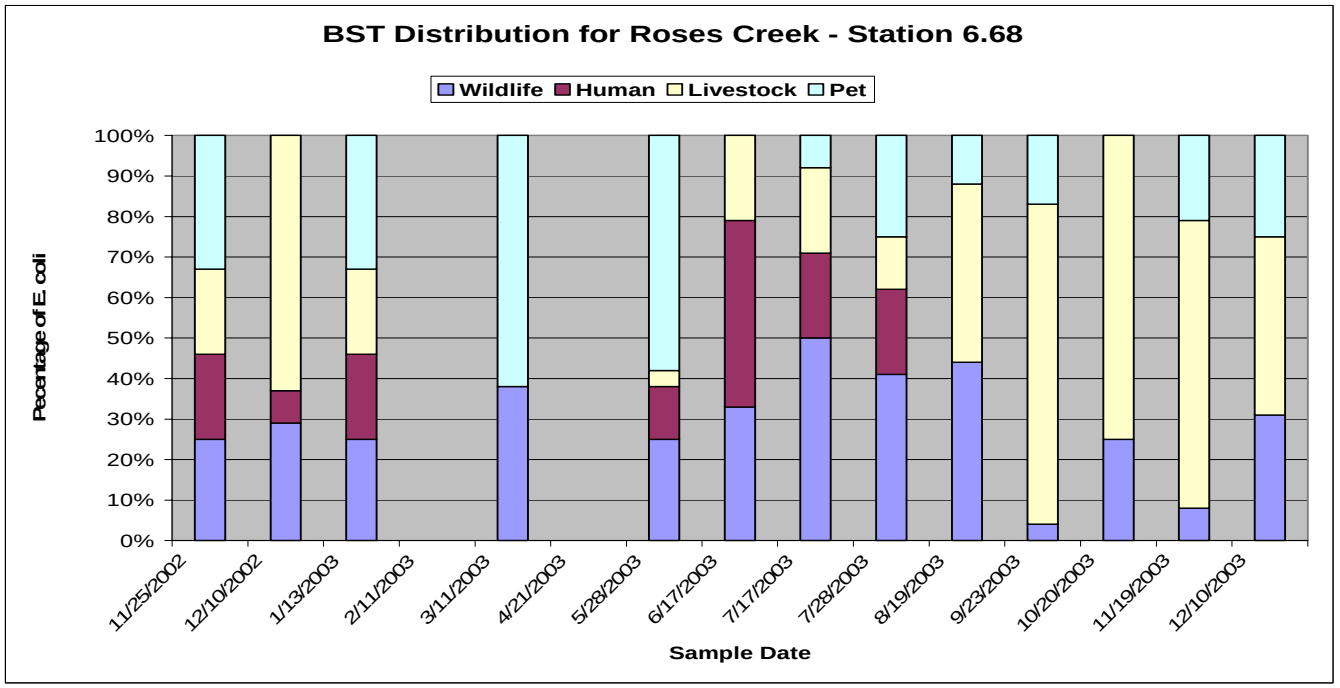
Based on two stations and 15 samples collected at each station, the results indicate that bacteria from human, livestock, wildlife, and pet sources **is present** in Roses Creek

Bacteria Source	Range
Human	0 – 62%
Livestock	0 – 88%
Wildlife	0 – 50%
Pet	0 - 92%

Bacteria Monitoring Results




BST Distribution for Roses Creek - Station 1.22
Wildlife
Human
Livestock
Pet
Percentage of E. coli
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
11/25/2002
12/10/2002
1/13/2003
2/11/2003
3/11/2003
4/21/2003
5/28/2003
6/17/2003
7/17/2003
7/28/2003
8/19/2003
9/23/2003
10/20/2003
11/19/2003
12/10/2003
Sample Date


BST Distribution for Roses Creek - Station 6.68
Wildlife
Human
Livestock
Pet
Percentage of E. coli
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
11/25/2002
12/10/2002
1/13/2003
2/11/2003
3/11/2003
4/21/2003
5/28/2003
6/17/2003
7/17/2003
7/28/2003
8/19/2003
9/23/2003
10/20/2003
11/19/2003
12/10/2003
Sample Date

Total Maximum Daily Load

TMDL

TMDL Expression

$$TMDL = \sum LA + \sum WLA + MOS$$

LA = Load allocation (nonpoint source contribution)

WLA = Waste load allocation (point source contribution)

MOS = Margin of safety

Allocation Objective

E. Coli not to exceed:

- 126 cfu/100ml GM Standard and
- 235 cfu/100ml Instantaneous Standard

Allocation Scenarios

Scenario	Failed Septics & Pipes	Direct Livestock	NPS (Agricultural)	NPS (Urban)	Direct Wildlife	E. coli Percent violation of GM standard 126 #/100ml	E coli Percent violation of Inst. standard 235 #/100ml
0						60%	48%
1	100					60%	48%
2	100	50				29%	48%
3	100	100				1%	48%
4	100	100	100	100		0%	0%
5	100	100			50	0%	48%
6	100	100			75	0%	47%
7	100	100	98	98	75	0%	0%
8	100	100	98	98	50	0%	0%
9	100	100	98	98	0	0%	0%
10	100	100	97.5	97.5	0	0%	3%
11	100	100	96.7	96.7	0	0%	10%

Existing and Allocated E. Coli Loadings

Land Use/Source	Annual Average E. coli Loads		Percent Reduction (%)
	Existing	Allocation	
Forest	3.19E+11	3.19E+11	0
Cropland	1.70E+10	4.66E+08	97
Pasture	8.46E+12	2.32E+11	97
Low Residential	7.98E+12	2.19E+11	97
High Residential	4.43E+10	1.22E+09	97
Commercial/Industrial	1.72E+10	1.72E+10	0
Water/Wetland	1.50E+09	1.50E+09	0
Failed Septic	7.70E+05	0E+00	100
Cattle Direct	4.21E+09	0E+00	100
Wildlife Direct	2.64E+08	2.64E+08	0
Point Source	3.24E+10	3.24E+10	0
Total loads /Overall reduction	**1.69E+13**	**8.23E+11**	**95**

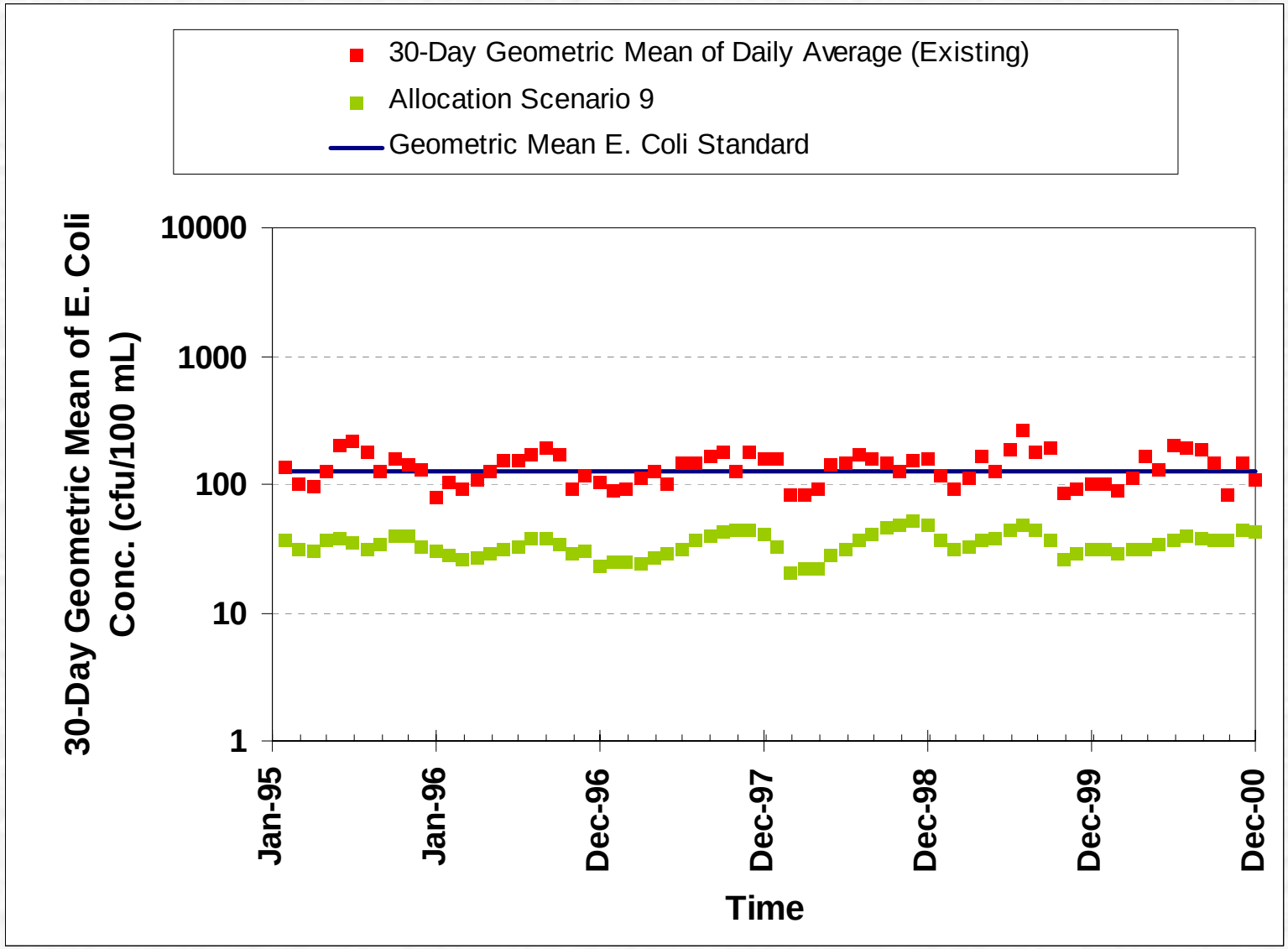
Land Based Load

1: Translation from fecal coliform to E. coli standards changed percent reduction by NPS from 98 to 97 percent.

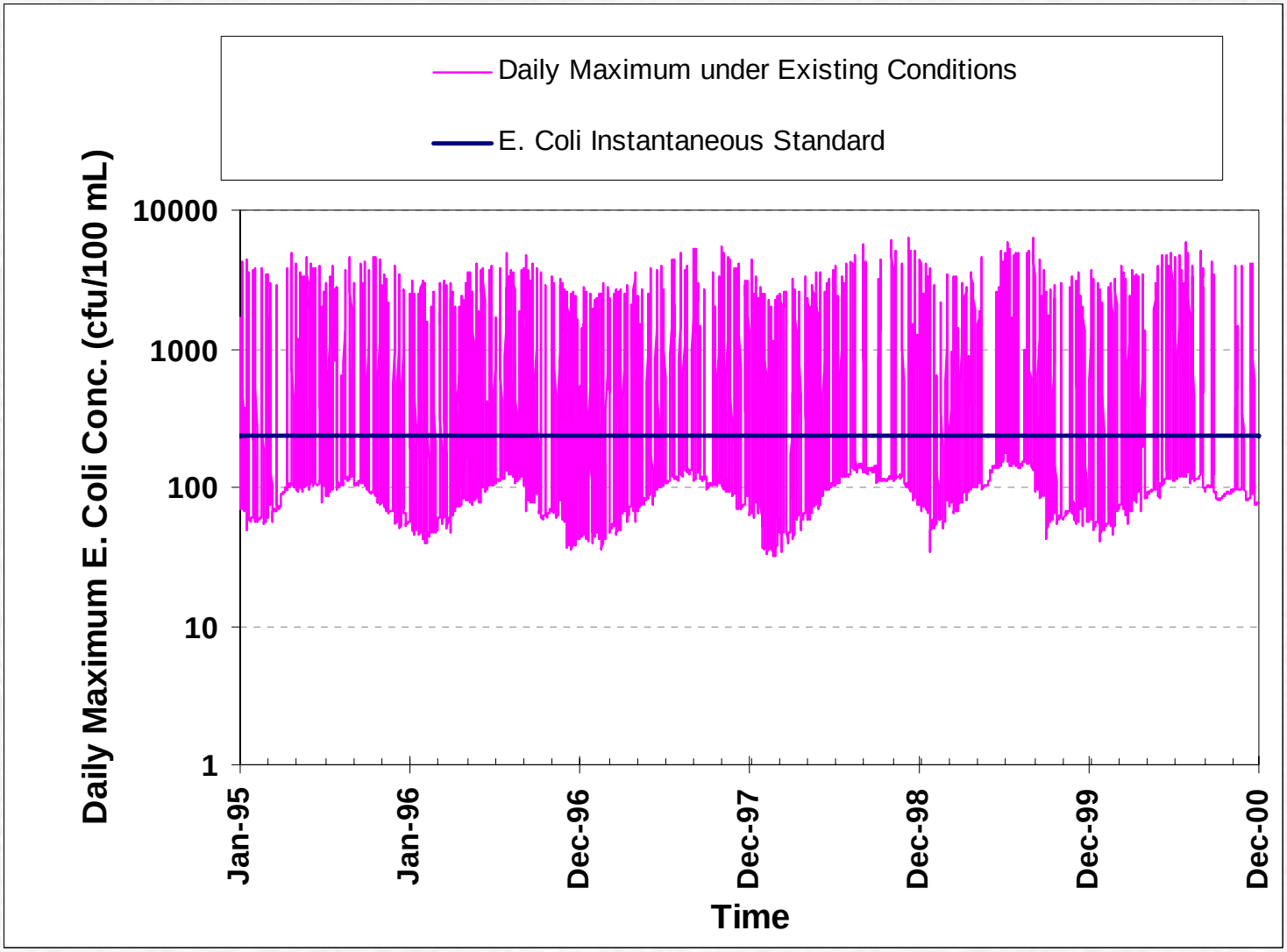
E. Coli TMDL Expression

Point Sources (WLA)	Nonpoint sources (LA)	Margin of safety (MOS)	TMDL
3.24E+10	7.91E+11	Implicit	8.23E+11

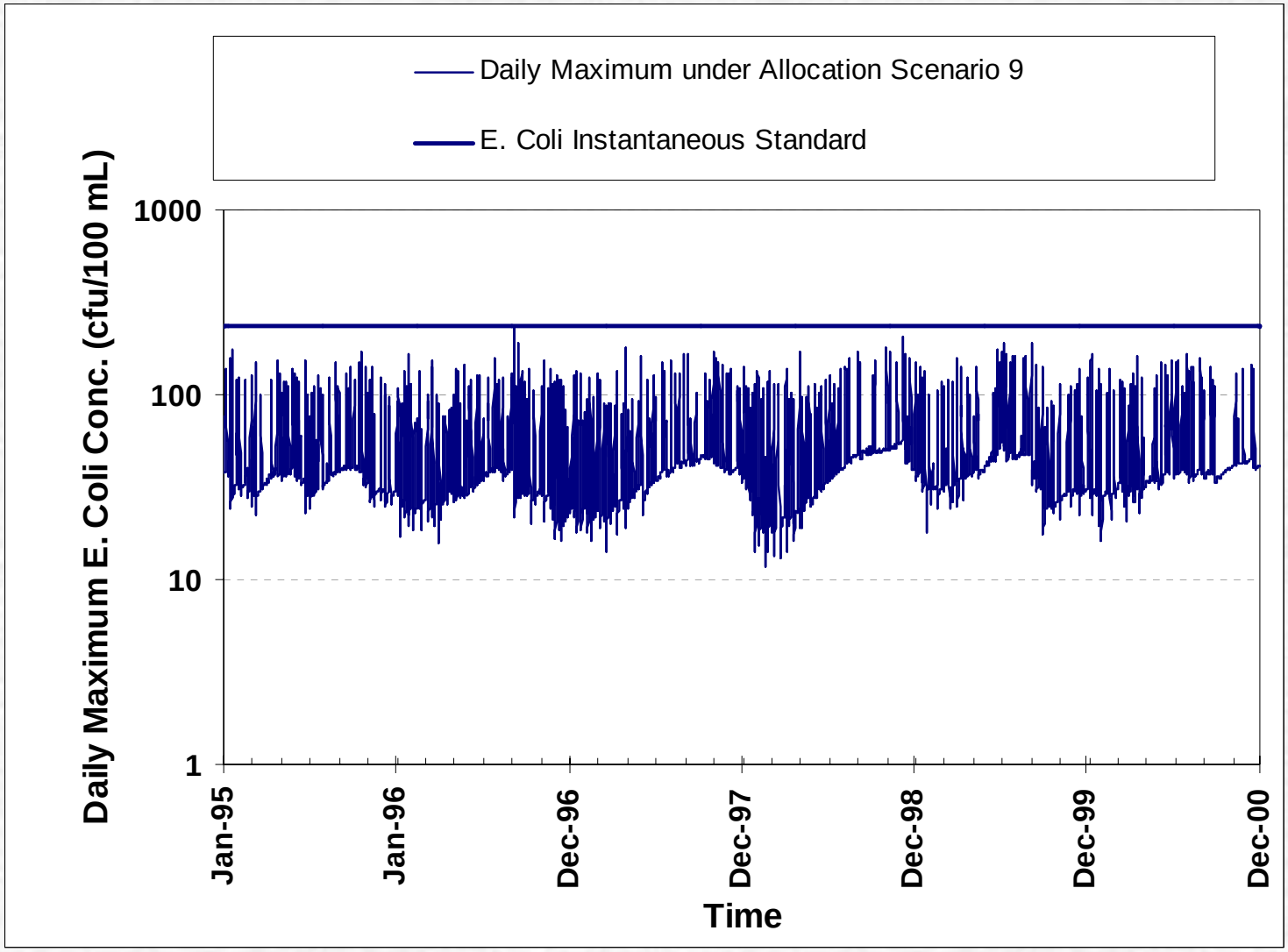
Allocated E. Coli Loadings (GM)



Existing E. Coli Loadings (Instantaneous)



Allocated E. Coli Loadings (Instantaneous)



Phase I: Implementation

- Objective:
  Not to exceed the instantaneous E. Coli standard of 235 counts/100ml more than 10% of the time.

Phase I: Implementation

Scenario	Failed Septic Systems & Pipes	Direct Livestock	NPS (Agricultural)	NPS (Urban)	Direct Wildlife	Percent violation of Inst. standard 235 #/100ml
1	100	100	96.7	96.7	0	10%
2	100	100	70	70	0	43%

TMDL Summary

- BST results indicate that there is a human, livestock, wildlife, and pet contribution to the total available fecal coliform loading.
- The goodness of fit shows that the model is calibrated and representative of the hydrologic conditions of the watershed.
- A TMDL allocation plan to meet the geometric mean water quality goal of 126 cfu/100ml and the instantaneous water quality goal of 235 cfu/100ml requires:
  - 100% reduction in septic and straight pipes
  - 100% reduction in direct deposition from cattle to stream
  - 98% reduction from agricultural nonpoint sources
  - 98% reduction from urban nonpoint sources
  - 0% reduction in direct deposition of from wildlife to stream
- A phase 1 TMDL implementation plan to meet the instantaneous water quality goal of 235 cfu/100ml with less than 10% violations requires:
  - 100% reduction in septic and straight pipes
  - 100% reduction in direct deposition from cattle to stream
  - 96.7% reduction from agricultural nonpoint sources
  - 96.7% reduction from urban nonpoint sources
  - 0% reduction in direct deposition of from wildlife to stream

Next Steps

- Incorporate comments
- Draft TMDL Report
- Respond to public comments
- Final TMDL Report
- Submit TMDL Report to EPA

Local TMDL Contacts

Department of Environmental Quality
Christopher French - 804-527-5124
rcfrench@deq.state.va.us
www.deq.state.va.us

The Louis Berger Group
Raed EL-Farhan – 202-912-0307
relfarhan@louisberger.com